Space Weather Technical Forecast

Issued on Wednesday, 18 January 2023 at 12:55 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Further R1/R2 Radio Blackouts likely. G1/Minor Geomagnetic Storms likely Days 1 and 2 (18-19 Jan), risk declining later in the period.
Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate over the past 24 hours, with a couple of M-class flares, both peaking at M1.8 at 17/2329 UTC and a more recent one at 18/1035 UTC. Both these flares emanated from the largest and most complex region on the disc, AR3190 in the southeast. AR3192 in the northeast is also a large region, which contains a weak delta spot, with AR3190 also containing delta spots. The remaining seven regions appear stable for now with some regions showing signs of fading. A new and unnumbered sunspot region continues to develop in the northeast, but appears to be stable for now.

No new Earth-directed CMEs have been observed in available coronagraph imagery. There are numerous mostly small filaments on the disc at present, however the largest currently straddles the solar meridian near 30S and could give an Earth-directed CME should it this filament lift-off the Sun.

Solar Wind / Geomagnetic Activity: The solar wind, as measured at L1 by DSCOVR and ACE, showed a gradual decline to ambient levels, before a CME arrived at 17/2115 UTC. Wind speeds were slightly elevated to start, slowly declining to ambient, before jumping back to slightly elevated as the CME arrived, peaking at around 490km/s, before gradually declining to near 430km/s at present. The density has been average or above average, with a peak of 24 ppcc due to the arrival of the CME. The IMF was weak, but became moderate at around 15 nT with the CME arrival. The north-south component varied weakly, but became moderately southward directed after the CME arrived down to -12 nT. The phi angle was initially variable, but became predominately positive (away from the Sun) from 17/2100 UTC. Geomagnetic activity was Quiet to Unsettled, with Active intervals between 18/0000-0300 UTC and 18/0300-0600 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16 has been at Background levels throughout.

High energy electron flux (greater than 2 MeV) has been at background to moderate levels, peaking at 553 pfu at 17/2235 UTC. The 24-hour integrated electron fluence stayed below the Active threshold on a fairly flat trend, reaching 1.47e7 integrated pfu at 18/0001 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to be moderate, with a slight chance of reaching high levels. There are numerous regions on the disc, but the most obvious candidates for a significant flare are AR3190 and AR3192.

Solar Wind / Geomagnetic Activity: The arrival of a CME overnight is likely to give increased geomagnetic activity at Earth, with effects from this likely to last through much of Day 1 (18 Jan).

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A second CME that was launched on 14 January may also give a glancing blow either late on Day 1 (18 Jan) or early on Day 2 (19 Jan). In addition, two small coronal holes may give some weak high speed stream (HSS) influence late Day 1 into early Day 2 with wind speeds up to around 500 km/s. A further HSS is possible from CH68 during Day 3 (20 Jan).
Geomagnetic activity is expected to often be Unsettled to Active with the Chance of G1/Minor Storm intervals likely on Days 1 and 2 (18-19 Jan), the risk declining slightly during Days 3 and 4 (20-21 Jan) as CH HSS and possible CME effects start to wane.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux observed by GOES16 is likely to remain at predominantly background levels, but with a slight chance of reaching S1 or greater through the period.

High energy electron flux reached moderate levels over the past 24 hours, but the recent CME arrival is expected to suppress levels in the near term. An increase is then possible later in the period. As such, electron fluence is likely to stay below the Active threshold for much of this period, but with an increasing trend into Day 4 (21 Jan).

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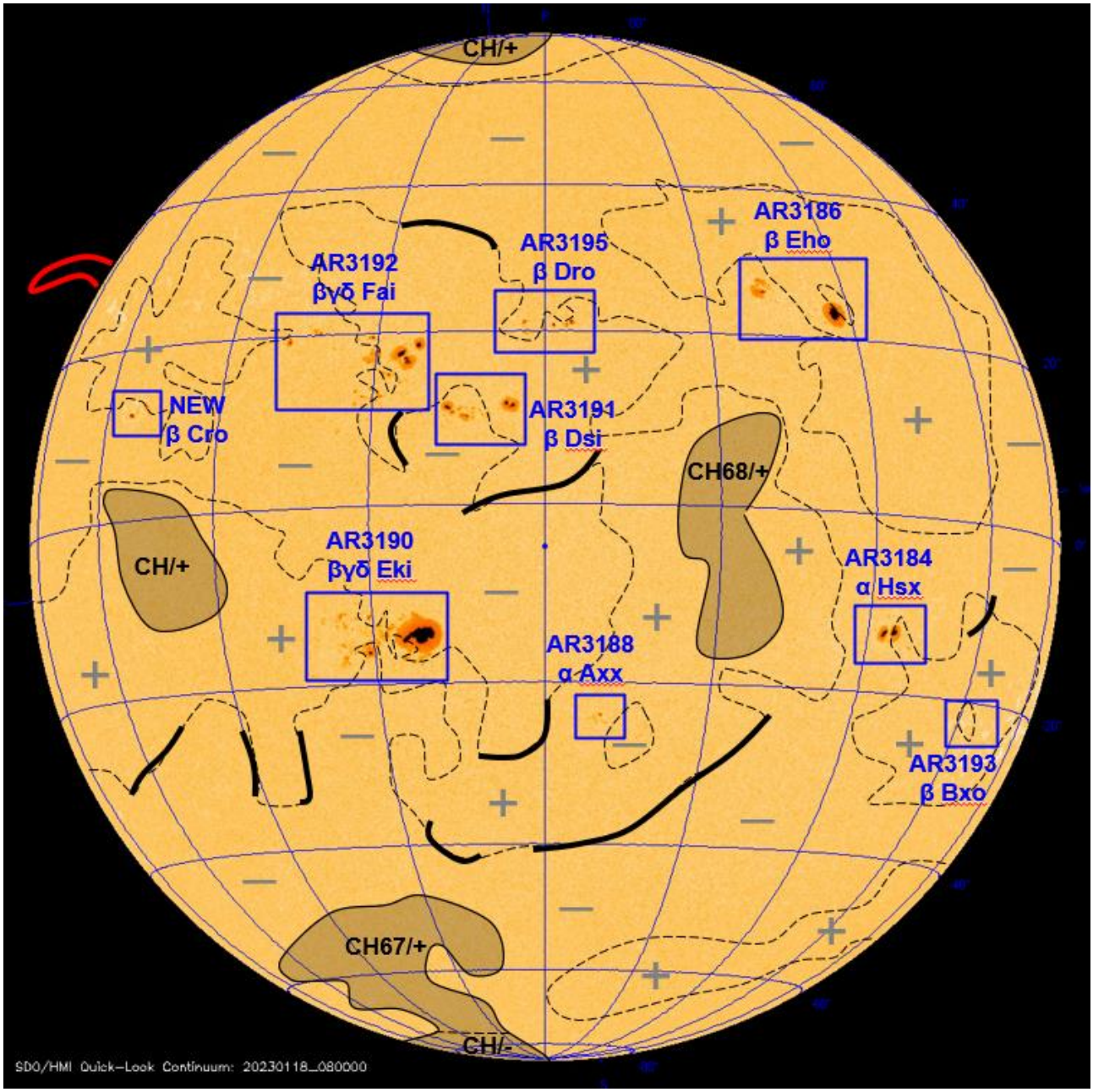
Figure 1. Solar Analysis Valid 18/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A recent CME arrival, likely one that was emitted on 15 January by AR3188 has increased geomagnetic activity at Earth, with Unsettled to Active intervals. However, the effects of the CME are likely to last through much of Day 1 (18 Jan). A second CME that was launched on 14 January from AR3182 may also give a glancing blow either late on Day 1 (18 Jan) or early on Day 2 (19 Jan).

In addition, two small coronal holes - CH65 and CH66 - may give some weak high speed stream (HSS) influence late Day 1 into early Day 2. They are quite different from the previous rotation, and as such persistence methods are not particularly helpful. However, MOSWOC Enlil does suggest that a fast wind of up to around 500 km/s may arrive, with any CIR perhaps bolstered by the possible CME glance from the 14 January CME. A further HSS is possible from CH68 during Day 3 (20 Jan), although this appears to be a much weaker feature than the previous rotation. The phasing of all of these features is of lower confidence, but at least some degree of enhanced geomagnetic activity is expected through much of this period.

Geomagnetic activity is expected to often be Unsettled to Active with G1/Minor Storm intervals likely on Days 1 and 2, the risk declining slightly during Days 3 and 4. There is also a chance of an isolated G2/Moderate Storm interval, mainly on Day 1, but with a declining risk into Day 2.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	70	50	40	20
Strong	G3	No	2	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
15/0900	Partial	AR3182	SW	400 km/s	18/2359 UTC	Glancing blow possible

Figure 2: MOSWOC ENLIL and Ensemble, which shows a possible CME arriving later today (around midnight UTC), with a weak HSS arriving at a similar time.

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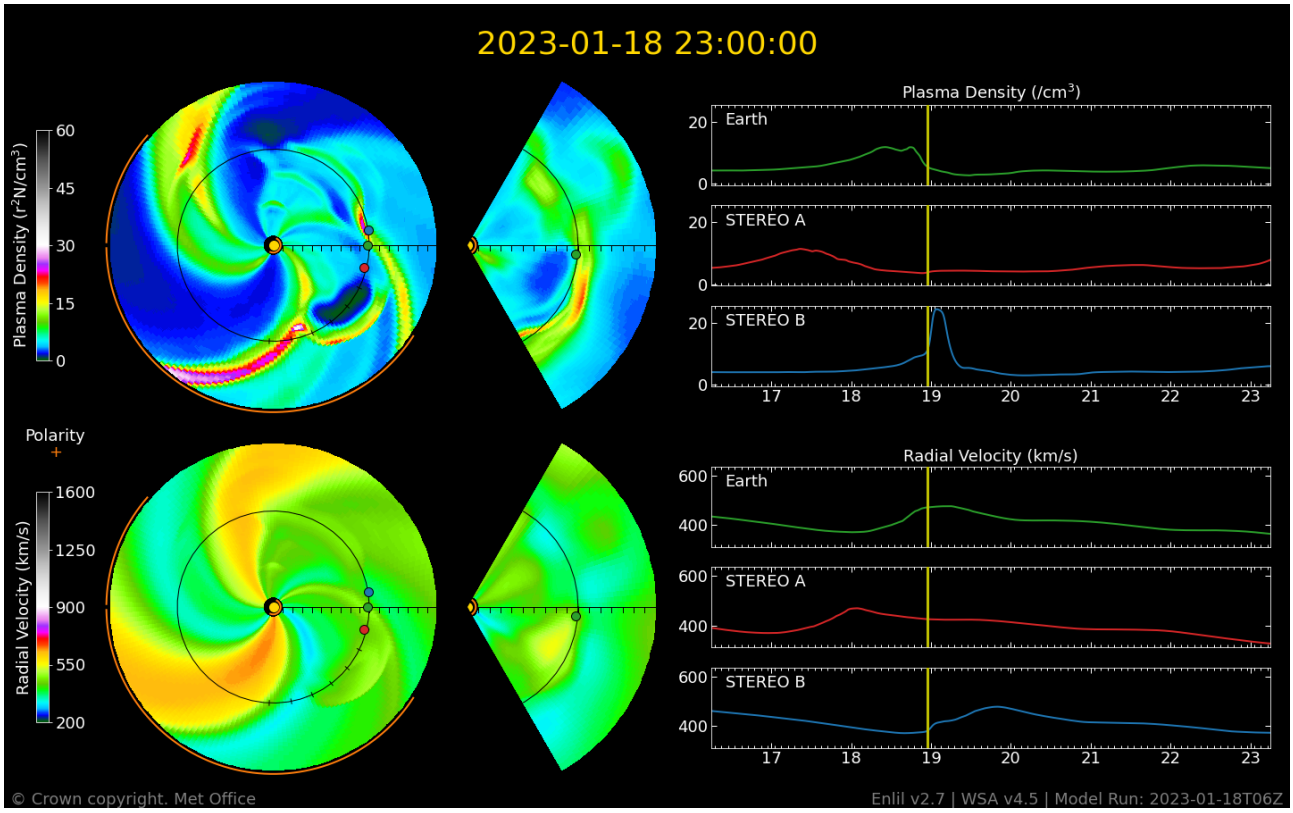

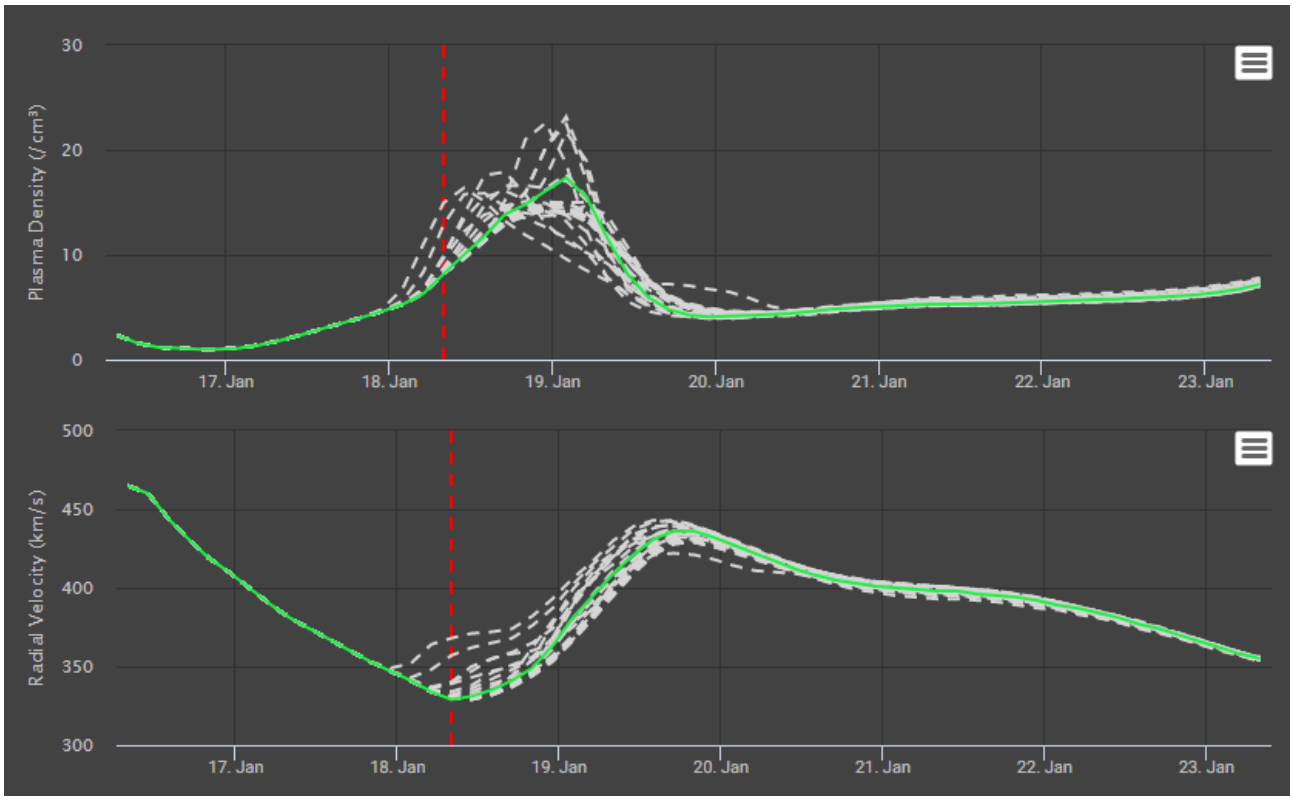

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Radio Blackouts - X-Ray Flares:
Solar activity has been Moderate through the past 24 hours, with a couple of M-class flares observed, both peaking at M1.8 and both of these flares emanating from AR3190, which is currently the largest and most magnetically complex on the disc. AR3190 (Eki/Beta-Gamma-Delta) and AR3192 (Fsi/Beta-Gamma-Delta) both remain relatively large and complex regions as both have small and weak delta spots. The other regions on the visible disc at present appear largely stable, with some appearing to fade a little. A new and unnumbered region has developed in the northeast, but appears to stable at present.

Far-side soundings suggest further regions may rotate onto the disc in the coming days, probably acting to maintain the risk of M-class flares through this period.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 M Class**	Yes	60	60	60	60
Very Active	**R3 to R5 X Class**	No	10	10	10	10

Figure 3: GOES-18 X-Ray flares – two M1.8 flares over the past 24 hours, both originating from AR3190.

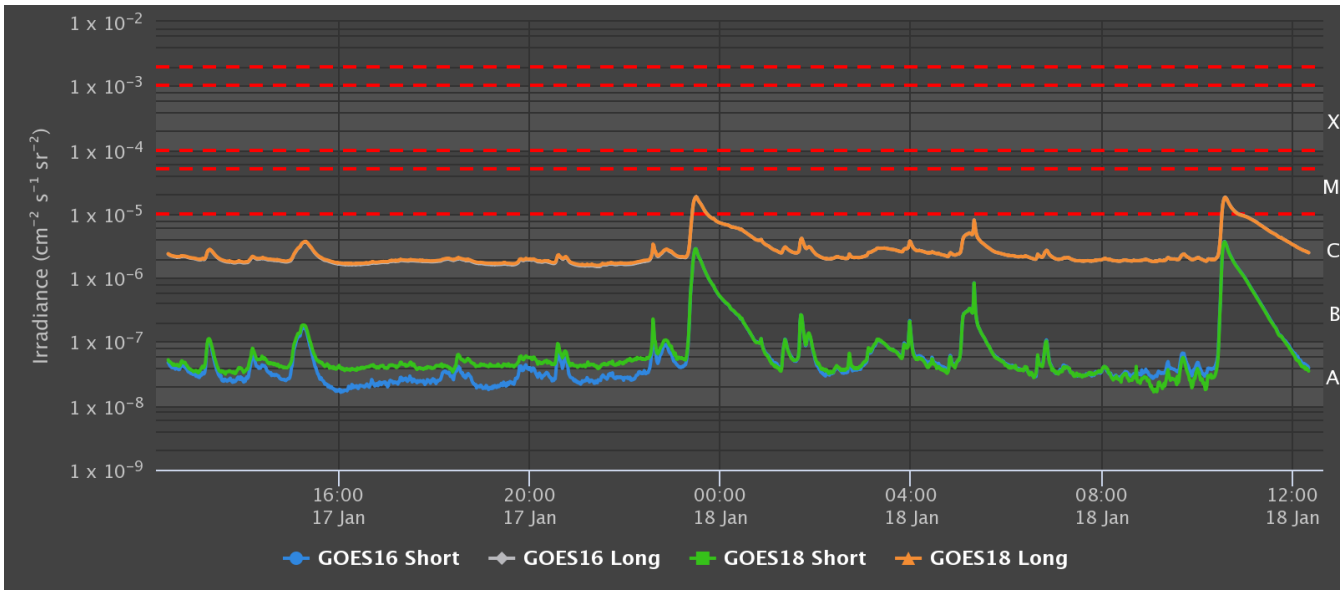

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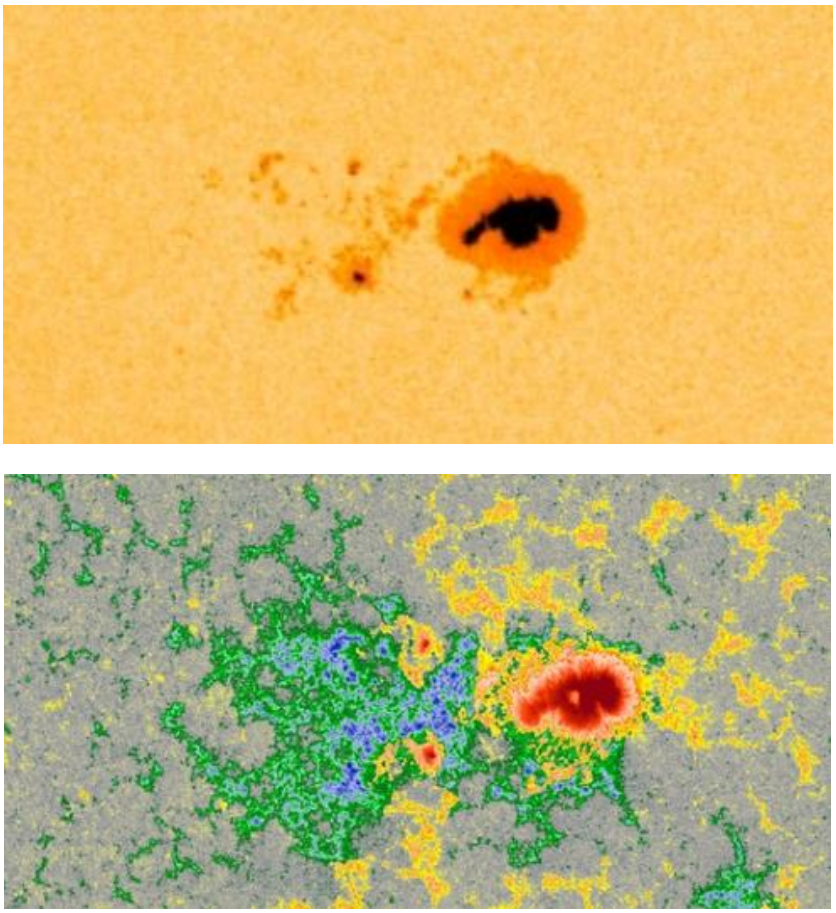
Figure 4: SDO/HMI intensitygram (above) and HMI magnetogram (below) – shows the magnetic complexity of AR3190, containing weak delta spots.



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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux is currently at background levels.

While no recent S1+ events have been observed at GEO, the sheer number of both front and far-sided complex groups dictates an elevated risk. While the relative contribution to the risk will decrease through the coming days for Ex-3182, both AR3190 and AR3192 bring an increasing risk as they rotate westwards. As such, a slight chance of S1 or greater continues through this four day period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux reached moderate levels over the past 24 hours, but the recent CME arrival is expected to suppress this in the near term. The possibility of another glancing blow from a further CME, perhaps combined with a weak HSS, is likely to continue the suppression into Day 2 (19 Jan) with a further HSS likely on Day 3 (20 Jan). An increase is then possible later in the period, probably on Day 4 (21 Jan), once the CME and HSS have begun to wane. It is difficult to judge the likelihood of significant electron charging occurring during this period until we see the strength of any HSS, however, so confidence in this is low.

As such, electron fluence is likely to stay below the Active threshold for much of this period, but with an increasing trend into Day 4. MOSWOC REFM is showing a level trend through the next 3 days, which is reasonable.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	10	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: MOSWOC Electron fluence and observations

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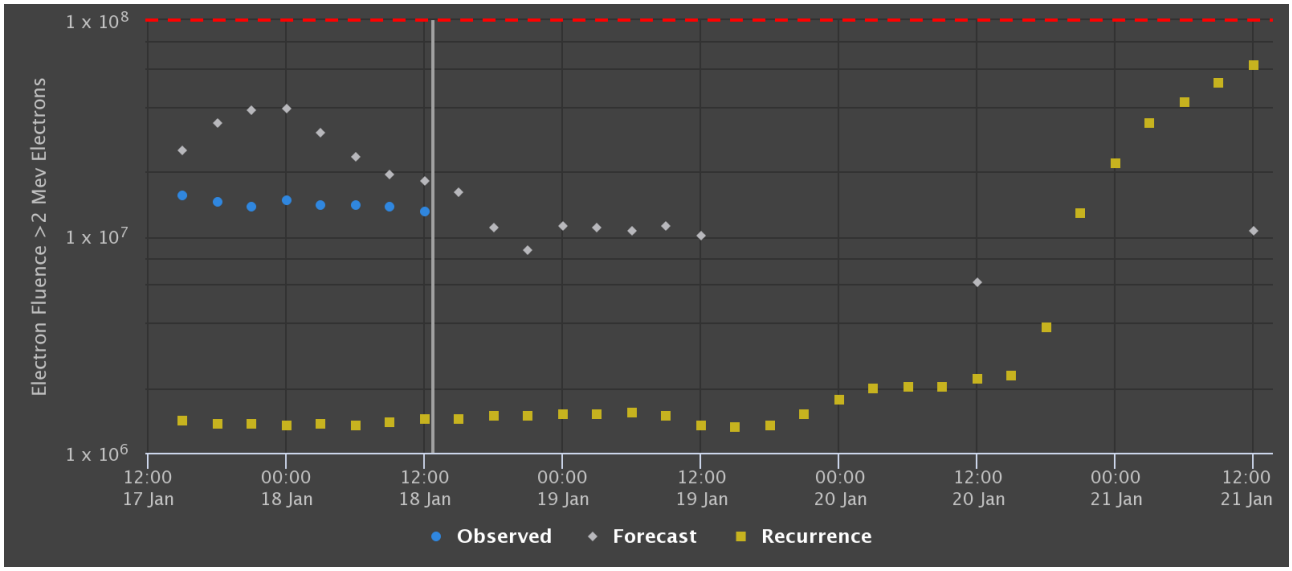

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